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IN THE

Supreme Court of the United States

OCTOBER TERM, 1930

No. 630

DEFOREST RADIO COMPANY
Petitioner

v.

GENERAL ELECTRIC COMPANY
Respondent

BRIEF FOR RESPONDENT ON PETITION FOR WRIT OF CERTIORARI

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References herein in the form "Vol. ....., p. ....." are to the printed record in the Circuit Court of Appeals for the Third Circuit.

References in the form of "I. R., p. ....." are to the record in the Court of Appeals of the District of Columbia in the interference between Langmuir and Arnold, which record has, by stipulation, become a part of the record in the present case (Vol. II, p. 927).

References to pages of the decisions of the District Court and of the Circuit Court of Appeals in this case and of the Court of Appeals of the District of Columbia in the Langmuir-Arnold interference are to the two pamphlets, one buff-colored and one green, containing those decisions, printed for the use of this Court by the respective parties.

Italics in quotations in this brief are not necessarily in the originals.

INDEX

PAGE

OPINIONS OF THE COURTS BELOW 1

JURISDICTION 2

Petitioner's Five Points 3

1. Because the decision was by a divided court in a case of great importance 3
2. Adamson *v.* Gilliland 4
3. Judge DAVIS' Reversal of Opinion 5
4. Degree of Vacuum 5
5. Judge WOOLLEY's Suggestion 6

STATEMENT OF THE CASE 6

ARGUMENT 10

The Dissenting Opinion 11

Opinion of the Law Examiner 11
Prior Art Publications and Patents 12
The Alleged DeForest Prior Use 14
Judge WOOLLEY's Mistaken Notion about Ionization 18
Judge WOOLLEY's Criticism of Plaintiff's Definition of the Invention 20
The Theory of Gaseous Conduction in the Prior Art 21
Judge WOOLLEY's Comments on the History of the Patent Application 25
The Issue of Priority 27

The Petition's Attack on the Opinion of the Court 28

BRIEF OF AMICI CURIAE 29

TABLE OF CASES.

	PAGE
Adamson *v.* Gilliland, 242 U. S. 350	4
Anaconda *v.* Carson, 278 U. S. 635; 26 Fed. (2d) 651	3
Brittania, The, 153 U. S. 130	5
Chemical Foundation *v.* General Electric Co., S. D. N. Y. (unreported)	29
DeForest Co. *v.* General Electric Co., on Coolidge Patent, 278 U. S. 656; 28 Fed. (2d) 641	6
Eibel Process Co. *v.* Minnesota Paper Co., 261 U. S. 45	5
Forsyth *v.* Hammond, 166 U. S. 506	2
Franc-Strohmenger *v.* Forchheimer, 277 U. S. 597; 280 U. S. 542; 20 Fed. (2d) 553; 27 Fed. (2d) 785; 39 Fed. (2d) 899	3
General Electric Co. *v.* DeForest Radio Co. (the present case in the District Court), 6 Fed. (2d) 704	1
Harkin *v.* Brundage, 276 U. S. 36	5
Keller and Lillie *v.* Adams-Campbell Co., 264 U. S. 314	2
Magnum Import Co. *v.* Cody, 262 U. S. 159	2
Marconi Co. *v.* DeForest Co., 243 Fed. 560	13
Woods, In re, 143 U. S. 202	2
Wetzler *v.* Tolfree, 278 U. S. 628; 25 Fed. (2d) 553	2

IN THE

Supreme Court of the United States

OCTOBER TERM, 1930.

DEFOREST RADIO COMPANY,
Petitioner,

v.

GENERAL ELECTRIC COMPANY,
Respondent.

No. 630.
Langmuir Patent
1,558,436.

ON PETITION FOR WRIT OF CERTIORARI
TO THE CIRCUIT COURT OF APPEALS FOR THE THIRD CIRCUIT.

BRIEF ON BEHALF OF RESPONDENT.

OPINIONS OF THE COURTS BELOW.

The opinion of the Court of Appeals of the District of Columbia awarding priority to Langmuir in the Patent Office interference between Langmuir and Arnold of the American Telephone & Telegraph Company is reported at 6 Fed. (2d) page 704. The opinion of the trial court holding invalid the Langmuir patent is at 23 Fed. (2d) 698. The memorandum decision of the Circuit Court of Appeals for the Third Circuit affirming the decision below,

Judge BUFFINGTON dissenting, is not reported. The opinion of the same Court on rehearing, sustaining the patent, by Judges BUFFINGTON and DAVIS, Judge WOOLLEY dissenting, which is the opinion the petitioner seeks to have reviewed, also has not been reported. For the convenience of the Court we have printed in a separate buff-colored pamphlet the opinion of the Court of Appeals of the District of Columbia, the memorandum of the Court of Appeals for the Third Circuit and the opinion of the Court of Appeals for the Third Circuit.

JURISDICTION.

The policy which this Court has followed with respect to the exercise of its unquestioned right to review by certiorari any patent case decided by any one of the nine Circuit Courts of Appeal, and the "necessary limitations upon our issue of the writ," as this Court put it in *Magnum Import Co.* v. *Cody*, 262 U. S. 159, 163, are expressed in Rule 38, and in *Keller and Lillie* v. *Adams-Campbell Co.*, 264 U. S. 314, *Forsyth* v. *Hammond*, 166 U. S. 506, 513-515 and *In re Woods*, 143 U. S. 202, 205, 206.

The present case is "an ordinary patent case with the usual issues," such as this Court said in the *Keller and Lillie* case it would "not bring here by certiorari unless it be necessary to reconcile decisions of Circuit Courts of Appeal on the same patent."

The decision of the Court of Appeals for the Third Circuit in the present case is in conflict with no other Circuit Court of Appeals. It is in harmony with the decisions of the Patent Office as to patentability in a strenuously contested proceeding. It directly follows the decision of the Court of Appeals of the District of Columbia on the issue of priority.

Petitioner's Five Points.

The petitioner urges five reasons why this Court should rehear the case:

1. Because the decision was by a divided court in a case of far-reaching economic, industrial and public importance.

The argument that certiorari should be granted because the Court of Appeals has by a two-to-one decision reversed the trial court has already been considered by this Court. Such was the situation in *Wetzler* v. *Tolfree*, where Judges WOOLLEY and DAVIS reversed Judge CLARK, Judge BUFFINGTON dissenting (278 U. S. 628). Such was also the case in *Anaconda* v. *Carson* (278 U. S. 635). In both of these cases certiorari was refused. Such also was the case in *Franc-Strohmenger* v. *Forchheimer* (277 U. S. 597), where the Court refused certiorari until a second Court of Appeals reached a different conclusion, when certiorari was granted; 280 U. S. 542 (see 25 Fed. [2d] 553; 26 Fed. [2d] 651; 20 Fed. [2d] 553; 27 Fed. [2d] 785, and 39 Fed. [2d] 899).

The case is important only in the sense that any suit on a patent on a great invention is important, whether the decision be for or against the patent. The present invention is one of the great contributions to the public good which have been made possible by the research of great scientists like Langmuir, Coolidge, Alexanderson and others, carried on in a thoroughly equipped research laboratory, organized and maintained by plaintiff at its sole expense.

The petitioner complains that the decision will give to the plaintiff a monopoly which will dominate the industry. But as Judge WOOLLEY has pointed out, the growth

of the radio industry has not been wholly dependent upon any single invention. On the other hand, it is inventions like this one which have made it possible for the industry to grow. Moreover, the Telephone Company and many radio tube manufacturers are licensed under the patent.

In any case it is difficult to see how the public interest would be served by granting a new monopoly, running seventeen years longer instead of twelve years longer, to the American Telephone & Telegraph Company, on the theory that Arnold and not Langmuir made the invention. But this is just what the American Telephone & Telegraph Company contended for by its counsel in the courts below (Vol. I, p. 399), and is now contending for in a suit under R. S. 4915, pending in the Southern District of New York (Vol. III, p. 1786), and the alleged priority of Arnold over Langmuir is one of the main points discussed in the petition.

The petitioner complains that unless the decision is reversed it will be compelled to discontinue the manufacture of the same devices that it has manufactured and sold since 1906. This is of course absurd. The decision does not purport to prevent petitioner from manufacturing the type of tubes which it manufactured and sold in 1906. Petitioner has abandoned the manufacture of such tubes in favor of tubes which it admits infringe the patent (Vol. I, p. 39).

2. Because the decision is in conflict with the rule stated by this Court in *Adamson v. Gilliland* (242 U. S. 350).

Neither the issue of priority nor the issue of prior use turned on any disputed questions of fact, but upon the proper inferences or conclusions to be derived from facts which are substantially undisputed. Such being the case, the conclusions of the trial court are not binding upon

the Appellate Court. (*The Britannia*, 153 U. S. 130; *Harkin v. Brundage*, 276 U. S. 36.)

Moreover, on the issue of priority the findings of the Patent Office Tribunals and of the Court of Appeals of the District of Columbia in favor of Langmuir as against Arnold are certainly entitled to as much weight as the findings of the trial court.

On the issue of prior use, the testimony was not taken before the Court, so that the rule of *Adamson v. Gilliland* would not apply in any event.

3. Because of Judge Davis' reversal of opinion.

That a judge may, as he should, change his opinion, if on reconsideration he concludes he is wrong, is the purpose of the rules which provide for granting reargu-ments. Judge BUFFINGTON having written the opinion of the Court, it is fair to assume that the reasons he ex-presses are the reasons which led Judge DAVIS also to conclude that the patent is valid. As to the change from the first to the second argument, the opinion says:

> "As usual in litigation over a patent of great commercial value, the vast mass of expert specu-lation, the protracted argument covering days and with briefs that in the aggregate covered several hundred pages, the case, on reargument, narrowed to the simple question of the patent paternity of what is known commercially as the Langmuir tube."

4. Because the patent covers nothing more than a degree of vacuum.

This point is fully covered in the opinion of the Court. In support of the Court's conclusion we refer to the opinion of this Court in *Eibel Process Co. v. Minnesota Paper Co.*, 261 U. S. 45.

5. Because Judge Woolley suggested that this Court should review the case.

It is indeed a novel proposition that this Court should review a case at the request of one judge, just because he differs with the rest of the Court.

Any suggestion that the writ should be granted because there was a dissent in the Court of Appeals would seem to be disposed of by this Court's refusal to grant the writ in many such cases, for example, in a suit between the present parties when the same Court of Appeals held invalid the product claims of plaintiff's important Coolidge patent for the drawn tungsten wire, Judge BUFFINGTON dissenting (278 U. S. 656; 28 Fed. [2d] 641).

STATEMENT OF THE CASE.

This is a suit for infringement of patent 1,558,436 granted to General Electric Company as assignee of Irving Langmuir.

Defendant admits infringement of every claim of the patent (Vol. I, p. 39). It asserts, however, that the invention is unpatentable in view of the prior art and because of prior use by defendant itself; or, if patentable, that Arnold of the Telephone Company, and not Langmuir, was the first inventor.

The invention is an improvement in electrical discharge devices, of the type commonly known as radio tubes, in which current flows through evacuated space from a hot cathode or filament to a cold anode or plate. A tube of this type is called a "hot-cathode tube."

The first practical radio tube was the Fleming valve, a two-electrode tube.

DeForest improved upon the Fleming valve by adding a third electrode called the grid. This was the DeForest audion.

Both the Fleming valve and the DeForest audion were "gaseous" tubes; that is, the flow of current from the filament to the plate depended upon the conductivity of the small amount of gas remaining in the tube.

The conductivity varied with the density of the gas, and the density varied in different tubes and in the same tube under different conditions, due in part to the gradual evolution of gas from the various parts of the tube, particularly from the plate. As the Court said (p. 10 of the buff pamphlet) quoting from Langmuir's testimony at Volume II, page 1242:

> "in the devices of the old art, in the DeForest audion, the pressure was continually changing. It sometimes increased and it sometimes decreased. Both things went on and there was an evolution of gas, water vapor would come off the bulb and be decomposed by the filament and it would generate gas. Gases would come out of the electrodes. Positive ions would bombard the walls and the electrodes and would drive gas off."

The consequence was that the current which a given voltage would produce in such a tube was not fixed and constant, but depended on the amount of gas present in the tube, and therefore varied in different tubes, and in the same tube at different times. Such tubes therefore required critical adjustment of the "B" battery voltage. As Gernsback said in 1911 (I. R., p. 1505):

> "It is undoubtedly true that the audion, when in its best condition, is highly sensitive and that it is therefore well suited for wireless telephony. But unfortunately *the sensitive condition is extremely difficult to find and still more difficult to maintain.* Some audion tubes show an extraordinary sensitiveness at first, but quickly grow dull when in use.

Other lamps are nearly worthless from the beginning and *none remain sensitive very long.*"

The art realized that this erratic behavior was in some way connected with the action of the gas, but they regarded it as an unavoidable thing in such a device. Both Fleming and DeForest and the art generally believed that if there was not enough gas in the tube to act as a conductor no current would flow, and experience confirmed this belief.

Langmuir defied the teaching and experience of the art. He made a tube in which the current flowed without gas.

The preparation of such a tube involved problems new in the art. It was not simply a matter of pumping a very high vacuum, which would be destroyed by the evolution of gas as soon as the tube was operated; the new and difficult problem was to get all the gas out of the parts of the tube so that there would be no further evolution of gas during the operation of the tube.

And when Langmuir had constructed such a tube, he found, contrary to the general belief, and for the first time demonstrated, that current would flow in what we may term a pure vacuum.

Moreover, the current, being unaffected by the gas, was steady and reproducible at any particular voltage.

Langmuir filed his patent application on October 16, 1913; two days later he presented before the American Physical Society a paper which was published in the December, 1913, issue of the Physical Review. It contains a full disclosure and explanation of his invention (I. R., pp. 1595-1596; Vol. II, p. 1234, Q194).

Shortly thereafter Langmuir's tubes came into commercial use; because of their stability, reproducibility and power they are used on a large scale in radio, in wire telephony and in other important applications.

In 1919 defendant issued a bulletin (Vol. IV, p. 158), in which it announced its discontinuance of the manufacture of the old audion and its adoption of the modern tube. In this bulletin it said:

> "The old style type T was an ionic or gaseous tube very unstable in operation and requiring a variable 'B' battery. It had the decided disadvantage that after continued use the tube would get 'hard' and require more 'B' battery until it reached such a state as to be inoperative. The new 'VT' tube, like the DeForest standard tubes to-day, is purely an electronic tube exhausted to a very high vacuum, so that it is nongaseous and will stand very high plate potentials. * * * The 'B' battery moreover, is not critical in adjustment and, therefore, a fixed battery may be used and is used for all practical work."

On the next page of the same bulletin it said:

> "The gaseous type tubes are, however, no longer being manufactured."

The tubes which were relied upon to prove the defence of prior use were some of the "old style" "ionic or gaseous" tubes, referred to in the bulletin quoted above.

The issues of patentability and priority were fought out and decided in the Patent Office. Arnold filed an application on November 2, 1915, which was thrown into interference with the Langmuir application. Arnold at once moved to dissolve the interference on the ground that the invention was not patentable in view of the prior art. Every conceivable prior art reference was cited and nearly two thousand pages of testimony were taken on the motion. After careful consideration, the Patent Office

concluded that the invention was novel and entitled to patent protection (I. R. pp. 2468-2470).

Thereupon the interference was proceeded with, the case being carried to the Court of Appeals of the District of Columbia, and resulting in a finding by that Court that Langmuir was the first inventor.

The defence of priority in the present case was conducted by the Telephone Company, which appeared by its own counsel and with its own witnesses (Vol. I, p. 399).

The case was heard before Judge Morris. The trial consumed more than four weeks. The record covers 3,678 pages, not including the Interference Record, which was stipulated in, and which covers 2,522 pages. In addition there was a great mass of documentary evidence and printed matter offered as physical exhibits.

Judge Morris decided for the defendant on every point, including the defences of prior use and priority.

The case was heard on appeal in the Circuit Court of Appeals for the Third Circuit by Judges Buffington, Wooley and Davis. The Court originally sustained Judge Morris in a short *per curiam* memorandum, Judge Buffington dissenting. A motion for reargument was allowed. The case was fully reargued, and the Court sustained the patent in an opinion by Judge Buffington, Judge Wooley filing a dissenting opinion.

ARGUMENT.

As Judge Wooley's dissenting opinion was written "with the hope that it will arrest the attention of the reviewing Court," and as the petitioner has adopted it as its brief on the merits of the case, we shall regard and answer it as such. We shall then dispose of the petitioner's single criticism of the majority opinion. In con-

clusion we shall say what we have to say about the brief filed by the Federal Telegraph and Telephone Company and others as *amici curiae*.

The Dissenting Opinion.

Briefly stated Judge WOOLLEY's position is that the invention is nothing more than a high-vacuum, or non-gaseous tube, and that a non-gaseous tube was old in the art. His conclusion is predicated upon three things:

FIRST.—An incomplete quotation from the opinion of the Law Examiner (p. 43 of the green pamphlet).

SECOND.—The prior art publications and patents (p. 44).

THIRD.—The evidence as to alleged prior use by De-Forest (p. 44).

The Opinion of the Law Examiner.

Judge WOOLLEY was so far misled by defendant's brief as to stop his quotation at such a point as to convey an incorrect impression of the Law Examiner's decision. The Law Examiner went on to say (I. R., p. 2468):

> "It is well settled, however, that the patentability of a combination is independent of the novelty of any of its constituent elements (Leeds *v.* Catlin, C. D., 1900, 549). *There remains for determination the question of the patentability of the combination as a whole.*
>
> * * * * * *
>
> "We may lay aside those alleged anticipating disclosures, such as Lenard, Gehrts and Dember, which pertain to photo electric devices using small currents of the order of 10^{-9} amperes or less. No effort was made at the hearing to include these within the scope of the count or the claims re-

tained and they are avoided by evident limitations, for example, space charge does not govern the flow of current in these devices. *It is not seen that any of the remaining references made fully available to the public by proper disclosure the device now claimed in the issue as reformed, or that the proposed combinations of references, with results not suggested by any one of them, were obvious.* The fact seems incontrovertible that a substantial and valuable contribution to the art has been made and that, within the limits explicitly stated or necessarily implied in the claims retained, it is entitled to patent protection."

The Prior Art Publications and Patents.

The Law Examiner was unquestionably right; of the various references, on which Judge WOOLLEY says "I stand" (p. 44 of the green pamphlet) some going back to 1881, long before radio was dreamed of, not one discloses Langmuir's tube, and not one suggests the results which Langmuir's tube accomplishes.

Doane, Malignani, Edison, Dwyer and Thatcher disclose old-style carbon-filament incandescent lamps and methods for evacuating them, which methods all produced vacua substantially the same as that in the old DeForest audion, which, as DeForest himself said, was the vacuum of the incandescent lamp (I. R., p. 1493). These citations are discussed in the record; see for example Vol. I, p. 250, XQs346-347; Vol. III, pp. 1571-1572; p. 1675, p. 1676; Vol. I, p. 225, XQs213-214; p. 221, XQs176-177; p. 232, XQ244; p. 231, XQ242; p. 360, Q1013; Vol. III, pp. 1689-1690. Of course they do not disclose "hot-cathode" tubes, or radio tubes, or anything of the sort.

Duncan discloses a tube, but not a hot-cathode tube; it is an old-fashioned gassy X-ray tube, with a cold

cathode, which had a gas pressure about the same as that in the old incandescent lamp or in the audion, and which worked only because of the gas which it contained (Vol. III, p. 1673).

Fleming discloses the old Fleming valve, which defendant's expert Chaffee admitted was a gassy tube (Vol. I, pp. 262, 263, XQs430-431) and which had the same vacuum as the old incandescent lamp and the old audion, as the Court of Appeals for the Second Circuit found in *Marconi v. DeForest*, 243 Fed. 560 (see also I. R., p. 1309).

The Lilienfeld articles relied upon were discussed by the Law Examiner at I. R., page 2469. They describe certain scientific experiments made in an attempt to prove an absurdly erroneous theory in physics (Vol. III, p. 1702; Vol. I, p. 334, XQs851-857; I. R., p. 3181). The single tube used in those experiments had no conceivable practical application, and carried its current by an action entirely different from that of a radio tube (I. R., pp. 1066-1071). When, a little later, Lilienfeld tried to make an X-ray tube with a hot cathode, he was unable to maintain the necessary vacuum, and contented himself, until Langmuir's work was published, with a tube which admittedly would not work unless it had gas in it (Vol. I, p. 280, XQs522-525).

The Bessel-Hagen article, published in the year 1881, describes some experiments made with a tube in which the gas pressure increased the moment the current was passed through the tube, to a value considerably higher than that in the DeForest audion (Vol. III, pp. 1669-1670; Vol. I, p. 342).

"Leonard" is undoubtedly the Lenard referred to by the Law Examiner in his conclusion which we have quoted above.

Von Beyer's pressure went up to the pressure in the audion when he lighted his filament (I. R., p. 2005).

Child worked only with tubes gassier than those of DeForest (Vol. III, p. 1695).

The Soddy patent, Defendant's Exhibit No. 17, is for a vacuum pump which has no relation to Langmuir's invention. The Soddy article, Defendant's Exhibit No. 18, discloses an experiment by which Soddy proved to his own satisfaction that *when a hot-cathode tube was thoroughly exhausted no current at all would pass through it* (Vol. III, p. 1580).

The Alleged DeForest Prior Use.

Judge WOOLLEY says (p. 46 of the green pamphlet) that DeForest "put into commercial practice for nearly three years before Langmuir, the very electron discharge of Langmuir's claimed invention." This is an amazing statement in view of the fact that DeForest was not called to testify in this case, and of the further fact that when DeForest subsequently offered his device to the Telephone Company as a telephone amplifier, the best he had to offer was a gaseous tube, which as he recognized and admitted (Vol. I, pp. 497-8), and as Arnold testified (Vol. II, p. 721), was "of practically no value in the telephone plant."

Judge WOOLLEY's conclusion is based upon the erroneous assumption that simply because certain audions may have operated at 54 or 67½ volts (as to which there is no proof), they must have operated without substantial ionization. He so finds, notwithstanding the facts that:

a. No witness has been willing to so testify;

b. The evidence, in so far as it shows anything about the operation of these tubes, shows clearly that they operated by gas ionization (Vol. II, p. 1008; Vol. III, p. 1616);

c. Both Langmuir (Vol. II, p. 1285) and Hogan (Vol. III, p. 1614) testified positively and without contradiction that the process of evacuation used with these tubes could not possibly have produced a vacuum sufficiently high to avoid substantial ionization, or anything better than the vacuum of an ordinary DeForest audion.

d. During the taking of depositions defendant had a tube exhausted by the same process, for the purpose of offering it in evidence, *but it was never offered and plaintiff was never afforded an opportunity to test it* (Vol. II, pp. 1060-1063 and p. 1042).

Judge WOOLLEY's error here, as elsewhere, is due to his complete misunderstanding of the difference in principle of operation between a gaseous and a non-gaseous tube. This is apparent from his statement (p. 42) that

> "The invention is an electron discharge tube which is *capable* of being operated below saturation and above ionization voltages."

This, of course, is not the invention. The old audion was "capable of being operated below saturation and above ionization voltages." It was in fact always so operated (I. R., p. 99), and depended, both as a detector and as an amplifier, upon the sharp rise of current due to ionization occurring at voltages above the ionization voltage (I. R., p. 2007, 2008; Vol. II, p. 1261). The Langmuir tube operates in the same range, *i. e.*, below saturation and above ionization voltages, *but it operates without substantial ionization effects*, and this is what the patent says.

Judge WOOLLEY has unquestionably been confused by the ambiguous statement of defendant's counsel, which is repeated in petitioner's brief (p. 19), that "the patent purports to cover any vacuum tube which can function *properly* when using 40 volts or more."

The old audion often functioned "*properly*" when using 40 volts or more, but whatever the voltage it always functioned by gas ionization. Defendant recommended for use with its old gaseous audions a *variable* "B" battery of 30 to 36 cells, which is 45 to 54 volts (Vol. IV, p. 135), and the instructions were to adjust the voltage to the point just below that at which blue glow occurred (Vol. IV, p. 140), which, as Langmuir explained, was in order to obtain the strongest ionization effects (I. R., p. 2007).

The Langmuir tube also functions "*properly*" when using 40 volts or more, but it functions without substantial ionization effects. Claim 26 of the patent, which is the claim to which petitioner refers, defines the tube as "capable of passing a sustained discharge of one tenth of a milliampere at 40 volts, *without developing any substantial positive ionization effects.*"

Counsel's statement "the patent purports to cover any vacuum tube which can function properly when using 40 volts or more" is true only when the word "*properly*" is understood to mean "without substantial ionization effects." It was this ambiguous use of the word "properly" which confused Judge WOOLLEY, and led him to conclude that any tube which functioned usefully at 40 volts or more, regardless of how it functioned, was a Langmuir tube.

The test is not whether a tube will operate usefully at any particular voltage, but *how* it operates. As to this there is one very simple but accurate test and that is to find out whether the current is constant at a given voltage under all conditions of the tube; whether the tube requires the critical adjustment of the B-battery voltage referred to in defendant's circular, as necessary with the old style gaseous tube, or whether "a *fixed* B-battery may

be used," as defendant's 1919 bulletin tells us is the case with the purely electronic tube.

Applying this simple test, we have positive evidence that Hewlett's tubes, for instance, whether they were operated as Judge WOOLLEY says, at 67½ volts, or as Hewlett himself said, at some lower voltage, were operating upon the principle of gaseous conduction. Hewlett testified (Vol. II, p. 1008):

> "The voltage depended upon the degree of exhaustion of the particular tube I had in use and I would say it ranged around about sixty volts, but I had a glass beaker with a thermometer and the tube in the oil of this beaker and by lighting a small alcohol lamp under this beaker I could somewhat control the amount of B-battery used for best results.
>
> "Q17. What was the effect of heating the vacuum tube in the manner you describe?
>
> "A. Heating the tube lowered the amount of B-battery used on the tube."

Referring to Hewlett's testimony, plaintiff's expert, Hogan said (Vol. III, p. 1618):

> "That is exactly like the tube heating that was commonly used by radio operators in the early years of the audion. The heat applied to the glass walls results in disengaging gas within the tube and therefore increasing the gas pressure in the tube and reducing the voltage at which a blue glow can be had, and also the operating voltage of the tube."

In other words, these tubes which Judge WOOLLEY now finds to be "the very electron discharge of Langmuir's claimed invention" are the identical old-art gaseous audions, which defendant in its 1919 bulletin (*supra*, p. 9) tells us "had the decided disadvantage that after

continued use the tube would become 'hard' and require more B-battery *until it reached such a stale as to be inoperative.*"

Judge Woolley's Mistaken Notion about Ionization.

The chief trouble with the dissenting opinion is that it proceeds from a fundamentally wrong conception of what ionization is, and the part which it plays in the flow of current in a gaseous tube.

Judge WOOLLEY said (green pamphlet, p. 42):

> "The ions (with their positive charges of electricity) fight against the electrons (with their negative charges) in the normal flow of the latter from the cathode to the anode, resulting at high voltages, in a blue glow which is the indication of bad action, a thing to be avoided."

At page 49 he speaks of gas as "an enemy to conduction."

Judge WOOLLEY is all wrong; yet this error is the basis of his findings against the patent, both on the question of novelty and priority. A similar error was the basis of the similar findings of Judge MORRIS.

The ions *do not* fight against the electrons; on the contrary they keep the electrons from fighting against themselves, and thus increase the flow of current across the tube (I. R., p. 1237). Gas is not an *enemy* of conduction. It is a *friend* of conduction, but an erratic and unreliable friend.

Ionization begins at a certain voltage, usually about 20 volts, but varying somewhat with different gases. When the voltage reaches that point the gas between the filament and plate begins to ionize or disintegrate and to form a sort of electrical conductor for the current. As the voltage

increases, the amount of ionization increases; as the ionization increases, the conductivity of the gas increases and thus the flow of current is increased out of proportion to the increase in voltage. The amount of this increase at any given voltage depends upon the amount of gas in the tube. This is why a tube which is operating on the principle of gas ionization is critical and unstable.

When the ionization becomes very pronounced it causes a blue glow in the tube. This occurs at different voltages in different tubes and in the same tube at different voltages, according to the varying density of the gas. In this condition the tube is generally inoperative. In the range above ionization and below blue glow the current is influenced by ionization, and it was in this range that the audion was always operated, preferably at the voltage just below the point at which blue glow appeared, so as to get the maximum useful effect of ionization.

What DeForest wanted, therefore, was a tube in which he could get the maximum useful effect of ionization with a reasonable operating voltage range. In 1906 he said, for example, "If the exhausting process is carried too far, the audion loses its sensitiveness" (I. R., p. 1496). In 1913, in a paper on his *amplifying* audions, he spoke of the air in the bulb being "exhausted to the *most effective* pressure" (I. R., p. 1498).

In his letter to the McCandless Company, DeForest said (Vol. VI, p. 1061):

> "Out of the last lot of 24 audion bulbs which you manufactured for us there are only 4 that came up to proper sensitiveness test. Apparently the vacuum in the other bulbs is too low, because in these latter bulbs we notice that the blue arc or cathode beam starts suddenly at 15 or 20 volts, under which condition the bulb is not sensitive."

Judge WOOLLEY finds that this letter showed that DeForest appreciated the necessity of a high vacuum. Of course it showed nothing of the sort. What it did show was that DeForest realized that when the vacuum was so low that the tubes blue glowed at voltages below that at which they were intended to operate, they were no good. He wanted a better vacuum than that, certainly; but all he wanted, or thought he could use, was the vacuum of a good audion; the "most effective pressure."

Judge Woolley's Criticism of Plaintiff's Definition of the Invention.

Judge WOOLLEY's misunderstanding of the effect of ionization, discussed above, accounts for his statement that our definition of the invention is inconsistent with the claims of the patent, and his further statement that "in interpreting and sustaining the patent broadly for a non-gaseous tube, the Court has given the plaintiff more than it ever dared to claim." We think that Judge WOOLLEY has misinterpreted the opinion of the Court. At page 38 of his opinion (green pamphlet), he quotes and criticizes our definition of the invention, and at page 40 he says:

> "The Court did not adopt the plaintiff's definition of coordinating elements with functional relations."

The fact is that this is precisely the Court's own definition, as clearly appears from page 17 of the buff pamphlet, where Judge BUFFINGTON says:

> "But a vacuum, or indeed change of vacuum, isolated and standing by itself, is not the Langmuir invention, but it is a working tube in which all the elements, cathode, plate, vacuum, so co-ordinate and interwork that current flow is not affected by gas."

We have endeavored to define the invention in such a way that the Court would understand it, sometimes using the technical language of the patent, sometimes attempting to paraphrase it in language which might be more intelligible to the Court. We have never intentionally or consciously attempted to define it as anything different from what the patent discloses. The expression "non-gaseous tube" is a convenient way of describing a tube in which gas is not present in sufficient quantity to affect the operation of the tube. It is exactly the phrase which the defendant used in its 1919 circular to distinguish its prior-art tubes from the new "purely electronic tube" which is the tube of the patent. To say that in the old-style gaseous tube the gas acted as a conductor, is a convenient way of expressing the fact which Langmuir stated when he said that positive ions took part in the conduction of current. To say that the invention consisted in taking out the gas conductor and substituting nothing in its place is a striking, but entirely fair, statement of the fact.

The Theory of Gaseous Conduction in the Prior Art.

Judge WOOLLEY takes issue with our statement that the prior art not only depended upon gaseous conduction, but thought it was the only way in which the tube would work. He concedes that if we were correct in our statement, there would be no doubt about what Langmuir did and no doubt that it was invention.

In our brief below on rehearing, we filled several pages with statements quoted from scientific publications by Fleming, DeForest and others, showing that our statement represented the generally accepted belief of the art. Some of them are quoted in the opinion of the Court. Judge WOOLLEY dismisses all these with the brief com-

ment that they are "carefully selected"; but neither defendant nor Judge WOOLLEY have quoted any statements to the contrary. Judge WOOLLEY says that we make no distinction between detector and amplifier, the inference being that the art recognized some distinction, but the uncontradicted evidence is to the contrary. Hogan testified that there was no difference between the gas pressure in an audion detector and amplifier (Vol. III, p. 1620), and as we have seen, the audion, whether as a detector or amplifier, depended for its operation upon the action of gas.

At page 50 of his opinion, Judge WOOLLEY quotes Langmuir as repudiating this theory of gas conduction. Here again he is wrong, as he would have seen if he had had before him and read Langmuir's entire statement, instead of relying on the incomplete excerpt quoted in the petitioner's brief below.

In the original specification Langmuir had said, describing the action in the old-style gassy tubes, "the positive ions take part in the conduction of current, giving at first erratic readings on measuring instruments connected in circuit." Judge WOOLLEY says that this is what the plaintiff now contends, but that Langmuir himself repudiates it.

The statement was subsequently cancelled from the specification and the following substituted:

> "Under these circumstances the phenomena of *conduction* across the tubes are the result of the action and interaction of the electrons and the ions. These phenomena are in general erratic and non-reproducible."

In cross examination, Langmuir was asked whether the original statement would have been true if it meant that

"the positive ions take part in the conduction of current *by acting as conductors or carriers of current.*" His answer was in effect that the statement would not be scientifically accurate. From this Judge WOOLLEY concludes that Langmuir repudiated the theory of gaseous conduction in prior-art tubes, but if he had read the whole of Langmuir's statement he would have seen that such was not the case, because Langmuir had just said (I. R. 1774, XQ67):

> "The sentence 'The positive ions take part in the conduction of current' is a perfectly natural way of expressing the fact that the presence of positive ions greatly increases the current under certain conditions. *In fact, since the current is increased as the result of the presence of positive ions, it is absolutely true that the positive ions 'take part' in the conduction of current.* It does not necessarily follow from this statement that the current is carried by the positive ions. The statement is simply a rather loose way of stating that the current is dependent on the positive ionization."

It is evident from this that the change was merely one of phraseology and not of substance, and that Langmuir never repudiated the theory of gas conduction in prior art tubes.

Judge WOOLLEY was also clearly wrong in saying that Langmuir did not in his specification refer to the audion as a device operating by gaseous conduction. At line 77 of the specification Langmuir says:

> "The phenomena above described as being characteristic of devices involving gas ionization are taken advantage of in an incandescent cathode device with three electrodes known as the audion. This device has been used as a receiver for radio

> telegraphy and *depends in its operation upon the rapid change of the discharge current when ionization begins.*"

Judge WOOLLEY quotes Langmuir's references to Lilienfeld, Von Beyer, Wehnelt and Richardson.

We have already referred to Lilienfeld and Von Beyer. We may here add what the Law Examiner said regarding Lilienfeld (I. R., p. 2469; see I. R., pp. 901 and 273);

> "The Lilienfeld device with its long, constricted tube is obviously impractical for any commercial purpose. The walls would tend to melt under electron bombardment and would become so hot as to furnish vapors under their own vapor pressure."

Judge BUFFINGTON refers in his opinion (p. 12 of the buff pamphlet) to the fact that Wehnelt, in a paper which he and Leibrich published in 1914, said that *ionization persisted in the best vacuum they could get* (I. R. p. 1427).

Judge WOOLLEY quotes Langmuir to the effect that Richardson had expressed the opinion that even in the highest vacuum thermionic currents could still be obtained. True, but this was pure theory; Richardson had never demonstrated it, and did not know how to, and actual experiments made by others seemed to disprove it, until Richardson himself began to doubt it (I. R. p. 1512). And when in November, 1912, Langmuir showed Richardson a tube in which current did flow in a vacuum, and explained to him the relation between the current and the voltage, Richardson was at first puzzled and then relieved (I. R. p. 510). And in the book, which he published later, Richardson refers to the phenomenon as:

> "an interesting effect which was discovered and explained by Langmuir" (Vol. IV, p. 339).

Judge Woolley's Comments on the History of the Patent Application.

The petitioner seeks to give the impression that the patent as it issued covered *an invention entirely different from that originally claimed when it was filed.* Judge WOOLLEY says something to the same effect, the obvious inference being that the invention underwent some change during the progress of the application through the Patent Office. He says in so many words that Langmuir "was far from certain what he had invented."

This is not a fair statement.

On October 18, 1913, two days after he filed his application, Langmuir read a paper before the American Physical Society in New York. It was published in the December issue of the Physical Review. No one can say that it does not contain a full, clear and accurate disclosure of the invention.

On December 28, 1913, before the Patent Office had taken any action on his application, he filed an amendment, adding four claims covering the tubes *per se*. One of these claims reads (Vol. VI, p. 876):

> "A high vacuum electron discharge device comprising an envelope, an incandescent cathode, and an anode, the space in said envelope being evacuated to such degree that the current produces no appreciable positive ionization when the impressed voltage is as high as 200 volts."

Claim 11 of the patent as issued reads:

> "A high vacuum electron discharge device comprising an envelope, an incandescent cathode, and an anode, the space in said envelope being evacuated to such degree that the passage of current pro-

duces no appreciable positive ionization when the impressed voltage is as high as 200 volts."

Certainly there is no substantial difference between the two claims.

A comparison of the original specification filed October 16, 1913 (Vol. VI, p. 662), with the specification of the patent as issued, shows that the essential portion, which is of course, as always, the description of the device itself and of the method of producing and of using it, is contained in the patent *in almost exactly the words of the original specification*, the only substantial exception being the elimination of one alternative suggestion relating to the process of evacuation which Langmuir then thought was a good one, but which he later found to be incorrect (Vol. II, p. 1276).

Langmuir understood well enough what his invention was. His patent solicitor seems to have had trouble in drawing claims which would accurately define the invention. That is an entirely different matter. It was not such an easy task as Judge WOOLLEY seems to imagine. He suggests that if Langmuir had invented the thing for which the Court gives him credit, he could have claimed it in a half dozen words, and suggests: "A non-gaseous discharge tube," or "an electrical discharge device with a high vacuum tube."

But these would not be good claims. "Non-gaseous" and "high vacuum" are relative terms; while sufficiently accurate to describe the invention in a general way, as we have used them in this brief, they are not sufficiently definite for a patent claim. As an absolute vacuum is an impossibility, the question would at once arise, how high a vacuum? As Langmuir says in his specification:

"The evacuation of the device should be preferably carried to a pressure as low as a few hundredths of a micron or even lower, *but no definite limits can be assigned.* The residual gas pressure should be below the value at which ionization by collision will take place *at the given working voltage and current.*"

In drawing the claims it was, therefore, necessary to define the invention in terms which would include all of the factors necessary to the operation of a tube by pure electron discharge, and if the Court will read the claims it will see that they are all directed to this end.

The Issue of Priority.

The Court of Appeals of the District of Columbia, affirming the decision of the Board of Examiners in Chief, held that Langmuir had conceived as early as September 1, 1912, and had reduced to practice by November 19th in the same year, and that Arnold had conceived and reduced to practice on April 25, 1913 (buff pamphlet, p. 22).

We have already said that the defense on the question of priority in this case was conducted by the Telephone Company by its own counsel and with its own witnesses, and that the Telephone Company has filed a suit in the United States District Court for the Southern District of New York under R. S. 4915, which suit is now pending awaiting final determination of this case.

Judge WOOLLEY would reverse the findings of the Patent Tribunals and the decision of the Court of Appeals of the District of Columbia upon what he says is evidence substantially greater than the evidence in the Interference proceedings. He does not point out wherein the evidence in this case is any more favorable to Arnold's contention than the evidence before the Patent Tribunals. The fact is quite the reverse.

The Petitioner's Attack on the Opinion of the Court.

The Court, correctly understanding the invention, appreciated that the essential difference between the tubes of the patent and the tubes of the prior art is the difference in principle of operation.

The petitioner challenges this conclusion, and asserts on the contrary that the principle of operation is the same; as the proposition was stated in petitioner's brief in the Court below, that "every electron discharge device functions the same, irrespective of the degree of vacuum."

The petitioner can find nothing in the record to support its contention, except the statement made by plaintiff's expert, Hogan, in testimony given in 1916 (Vol. III, p. 1681), in a case between different parties, involving different devices, which testimony petitioner cites without reference to its context. We might with equal propriety refer to the testimony of the petitioner's expert, Millikan, who testified in the same case regarding the Telephone Company's amplifiers, which were Langmuir tubes, that "they work upon an entirely different principle" (Vol. I, p. 118), which he explained was due to the fact that "they are evacuated to such a degree that the residual gases play no part in the operation" (p. 119).

Langmuir clearly explained this difference in principle of operation. His testimony is too long to quote, but it commences at Volume II, page 1236. *Not a single witness has challenged the correctness of his statement.*

The difference in principle of operation is illustrated in a practical way by a comparison of a gaseous and non-gaseous tube operating in the same receiver. The defendant's 1919 bulletin furnishes exactly this comparison. After explaining the difference between the "old style" "ionic" or "gaseous tube" and the new purely "electronic"

tube, the bulletin goes on to say (Vol. IV, p. 159) that the old-type gaseous tube may be used in place of the new high-vacuum tube, but in such case "a *variable* B-battery of from 20 to 50 volts is required" whereas with the new tube the instructions call for "a *fixed* battery of from 20 to 60 volts."

Here we have two tubes designed for use within the same range of voltage, one a gaseous tube, requiring a variable battery, the other a Langmuir tube operating with a fixed battery. The difference is due entirely to the difference in principle of operation. The gaseous tube, operating upon the principle of the conductivity of ionized gas, requires a variable battery to compensate for the varying conductivity of the gas; the non-gaseous tube, operating upon the principle of pure electron discharge, unaffected by gas ionization, works with a fixed battery at a predetermined and constant voltage.

BRIEF OF *AMICI CURIAE*.

The two numbered points in the brief filed by the Federal Telegraph Company and others are substantially identical with Points 2 and 4 on pages 16 and 21 of petitioner's brief and have been discussed above.

Most of the allegations of fact made in the brief are outside the record; some of them are clearly inaccurate; for example, the allegation on page three, that "the degree of vacuum shown in the Lilienfeld patents" referred to "is the same as that claimed in the Langmuir patent in suit." The fact is that the operation of the Lilienfeld X-ray tube, which his patents purport to cover, is inherently dependent upon the ionization of the gas left in the tubes, as defendant's expert Chaffee admitted (Vol. I, p. 280, XQs522-525). In *Chemical Foundation* v. *General Electric Company*, S. D. N. Y., not yet reported,

Judge THACHER held that the "operation of the Lilienfeld device is shown to be dependent upon ionization."

The Chemical Foundation's interest in this matter results from its owning the Lilienfeld patents.

We presume that this Court is not particularly interested in the relations between the General Electric Company and the Federal Telegraph Company. We wish, however, to point out, among the many misstatements of fact in the brief, the statement on page 7 that the communication systems of the Army and Navy would be subject to the domination of this patent. The American Telephone & Telegraph Company, Western Electric Company, General Electric Company, Westinghouse Electric & Manufacturing Company and the Radio Corporation of America have granted full licenses among themselves to manufacture for and sell to the Government for Government use under all their radio patents, including the Langmuir patent in suit (see, for example, Vol. IV, pp. 286 and 283).

The brief complains that the Court of Appeals did not "define the scope" of the patent which it holds valid. The scope of the patent is defined, as usual, in the claims. No question of scope was before the Court, since infringement of all of the claims was admitted. The Court therefore did not consider scope further than was necessary to its discussion of validity.

Respectfully submitted,

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